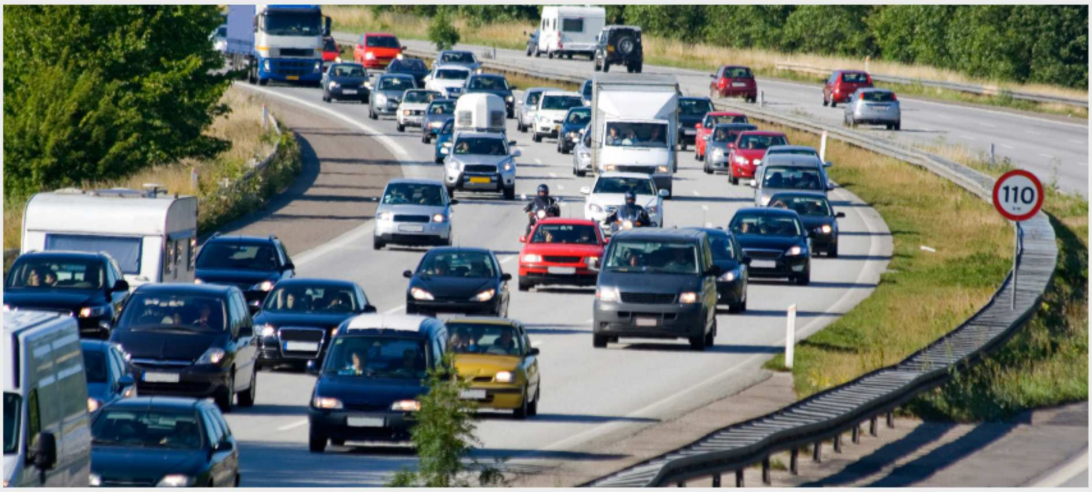

Green transport roadmap:

30% CO_2 reduction in EU road transport towards 2030

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Background

The EU has several collective environmental targets for the years 2030 and 2050 both in the EU Emission Trading System (ETS) and non-ETS sectors.

It is anticipated that the transition to a more energy efficient and decarbonised transport sector will largely be driven by EU policy. During the upcoming years, a number of important transport related decisions are expected to be taken within the EU. Most prominent among these are the CO_2 emission targets for new vehicles after current emissions standards expire for vans in 2020, and cars in 2021. When time comes for EU decision makers to formulate the next generation of EU transport standards it is important that they are aware of the costs, benefits and potentials associated with these policies.

The non-ETS target for the EU is a 30% reduction in $C0_2$ emissions by 2030 relative to 2005 (with member states obligations from 0 to 40%). The largest portion of emissions in this sector come from transport and agriculture, and the aim of this “Green transport roadmap " is to illustrate a cost-effective roadmap towards 2030 for reducing road transport emissions, thereby enabling road transport to contribute its proportionate share.

Green transport roadmap analysis

The analysis involves a concrete mix of technologies (electric vehicles, plug-in hybrids, biofuel blending, gas, etc.) that can be employed, taking into account the technologies' maturity, development potential, and societal costs. Two core assumptions in the project are that the technologies and tools identified are also expected to play a role after 2030, and that electricity will play a crucial role in transport towards 2050.

Two scenarios

The study comprises a business-as-usual (BAU) scenario and a 30% CO_2 reduction scenario. The BAU scenario assumes that the abovementioned 2020 and 2021 targets are met, but that more stringent targets are not put in place thereafter. The 30% reduction scenario is based on:

- an accelerated phasing in of electric drive vehicles,
- increased blending percentages in biofuels for all road vehicles
- introduction of biogas (primarily for heavy transport)

All three of the above are relative to a situation without new initiatives. Among other results from the scenario calculations the roadmap presents the socioeconomic cost differences between the two scenarios.

Highlights from the analysis

- Relative to 2005, the BAU scenario entails a 15% CO_2 reduction by 2030, and thus a 15% CO_2 reduction gap.
- By 2030, there is an annual net benefit from pursuing a 30% CO_2 emission. That is, relative to the BAU scenario, the price of reducing CO_2 emissions is negative.
- Electrification makes up the main contribution to the CO_2 emission reduction in the 30% scenario, and impacts the socioeconomics positively in the later years of the analysis period.
- The total amount of biofuels is doubled by 2030 compared to today with a significant increase in the usage of advanced biofuels

Results

Despite a growing road transport demand, increased vehicle efficiencies and greater electrification result in CO_2 emissions continuing to fall even in the BAU scenario, with 2030 emissions being 15% lower relative to 2010. Additional electrification, a higher degree of efficiency, and the introduction of more biogas results in the 30% reduction target being met in 2030.

In calculating the CO_2 emissions, all gas is assumed to be biogas (i.e. via certificates), and all biofuels and electricity are assumed to be CO_2 neutral. Ea Energy Analysis model calculations estimate an EU average CO_2 content of roughly 200 g/kWh in 2030, which if included would result in CO_2 emissions being 3.6% higher.

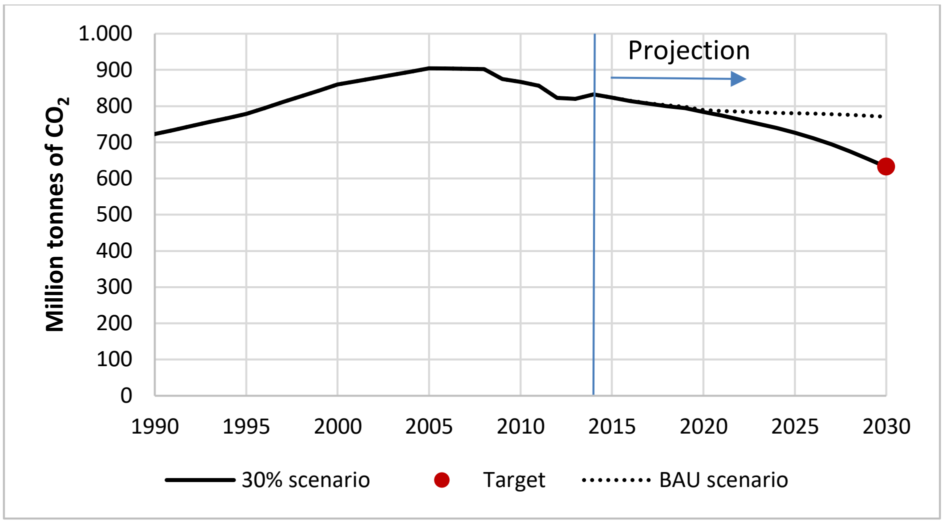

Figure 1: CO_2 emissions (million tonnes) from road transport in the EU28 countries

Compared to the situation in 2011, roughly 40% of the CO_2 emission reductions realised in the 30% scenario by 2030 are due to energy efficiency improvements of conventional vehicles. Electrification contributes with the second largest amount (35%), followed by increased consumption of biofuels (21%) and biogas (3%).

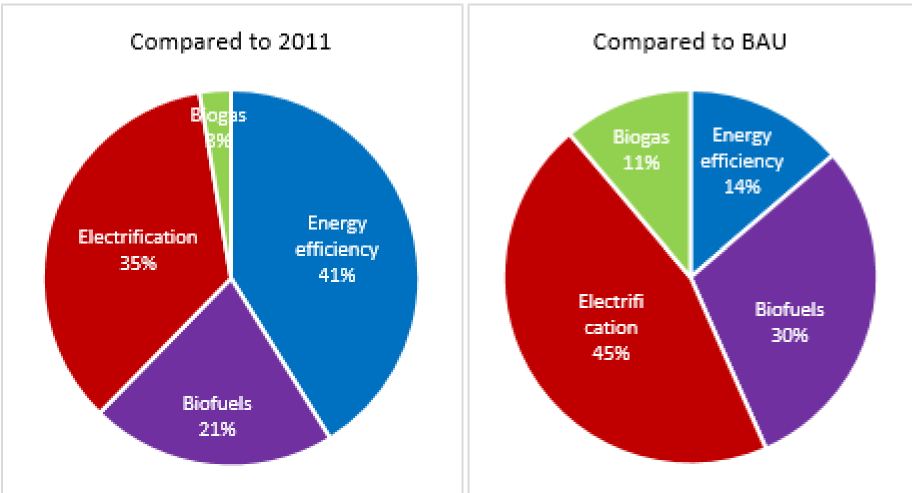

Figure 2: (left) Contributions to CO_2 emission reductions in the 30% scenario by 2030 compared to 2011 (right) Contributions to CO_2 emission reductions in the 30% scenario in 2030 compared to the BAU scenario.

When comparing the BAU and 30% scenarios in 2030, the contribution from electrification is more dominant, as the effect from energy efficiency improvement is already partially included in the BAU scenario.

Total energy consumption from EU road transport falls slightly in the BAU scenario, while it declines to nearly 10 EJ in 2030 in the 30% reduction scenario, with the sharp decline near the end of the period driven primarily by increased electrification.

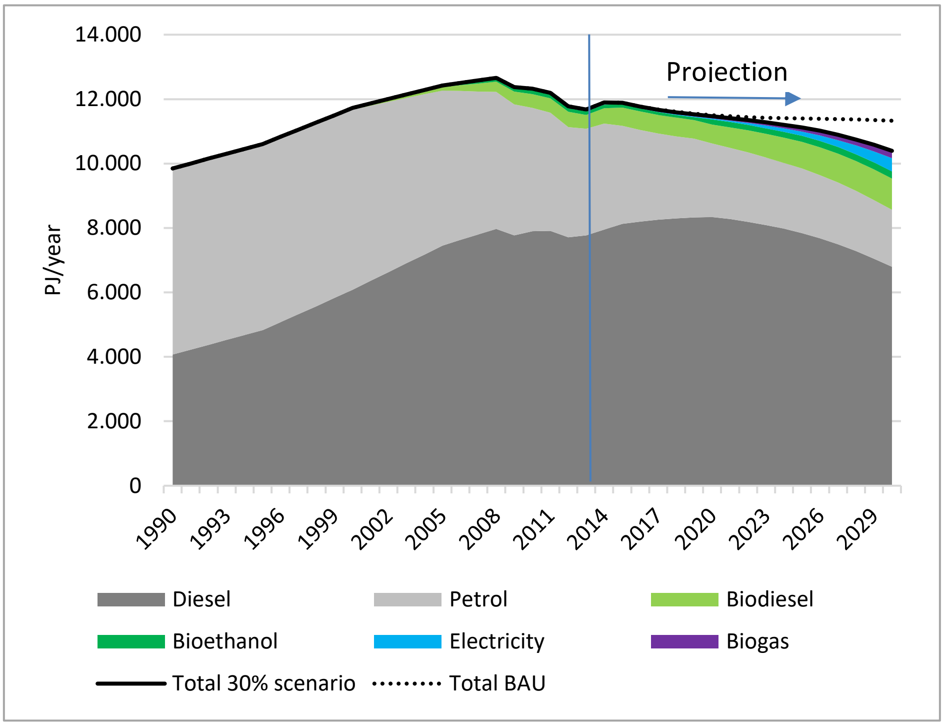

Figure 3: Total energy consumption for road transport in the EU28 countries

The 30% reduction scenario relies on an increasing amount of biofuels, particularly advanced (2nd generation) biodiesel and bioethanol. This leads to a reduction in conventional (1st generation) biofuels over the scenario period, but nearly a doubling in terms of total biofuel usage.

Biofuel (mio liters)	2014	2020	2025	2030
1.g FAME	14,980	17,060	14,750	11,590
2.g FAME	-	1,420	3,030	4,190
1.g syndiesel/HVO	-	-	-	-
2.g syndiesel/HVO	-	-	7,390	13,250
1.g bioethanol	5,260	6,830	3,370	560
2.g bioethanol		580	5,640	9,740
Total:	**20,240**	**25,890**	**34,180**	**39,330**

Table 1: Consumptions of biofuels (million litres) in the 30% scenario

In terms of the cost associated with the 30% reduction scenario relative to the BAU scenario, socioeconomic calculations were undertaken encompassing costs for vehicles, operation and maintenance (O&M), fuels, infrastructure and distribution, and externalities.

The annual net costs associated with the 30% reduction scenario increases in the period 2016-2025 and peaks around 2025 at roughly €5.8 billion, largely due to the higher upfront cost associated with electric (and to a lesser extent gas) vehicles. To put this figure into perspective, in the range of €300 billion was spent on new passenger vehicles alone in the EU in 2015.

During the later years (2025-2030) of the scenario period, these upfront costs become neutralised by fuel savings and a reduction in negative externality costs. The total net present value cost associated with the 30% scenario relative to the BAU scenario is €25 billion. It is worth noting that if the scenario period were extended beyond 2030, then the total net present value would soon become positive.

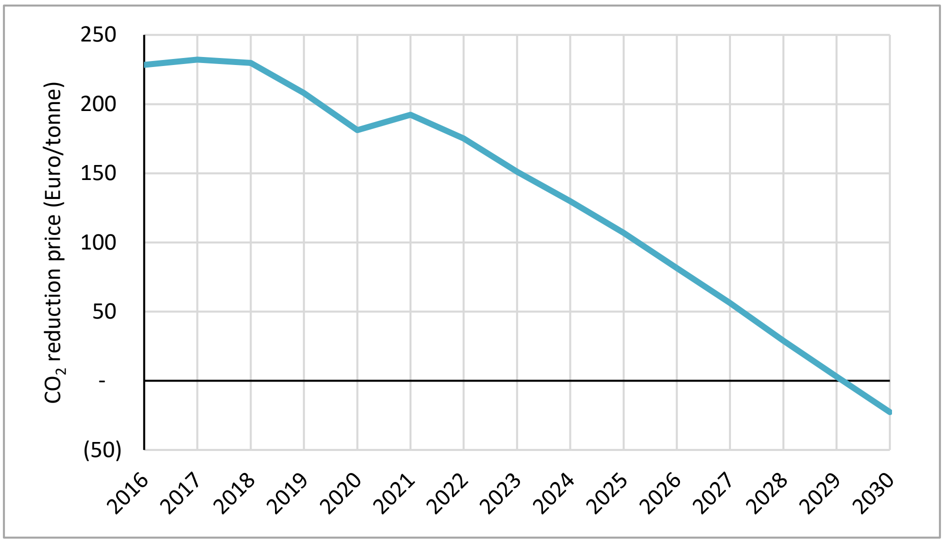

Figure 4: CO_2 emission reduction costs (Euro/tonne)

The resulting CO_2 shadow price, i.e. the cost of reducing 1 tonne of CO_2 in the 30% scenario relative to BAU scenario falls from over €230/tonne today, to slightly less than zero in 2030.

Method

The analysis involved the formation and evaluation of a 30% reduction scenario for potential road transport development towards 2030 (with CO_2 emissions reductions relative to 2005) for the EU28. In the scenario, the CO_2 emissions from road transport are reduced by switching from fossil fuels to renewables and due to increased vehicle energy efficiency. The scenario does not take into consideration measures aimed at reducing transport demand or shifting transport demand from private vehicles to public transportation.

The results are obtained by modelling the EU28 stock of vehicles, energy consumption and CO_2 emissions, and projecting the development hereof. This involved:

- Collecting data on the characteristics of the existing car fleet (passenger cars, LCV, HDV, city busses and coaches) including the stock of vehicles, new registrations, age of the existing vehicle fleet, average weight of vehicles, distribution according to drivetrains, motor efficiency etc.
- Modelling historical energy consumption and CO_2 emissions of the existing car fleet and calibrating this to the statistical energy consumption of EU road transport
- Projecting future road transport needs and analysing possible developments in terms of fuel economy, light weighting, electrification, etc.
- Setting up two scenarios: A BAU scenario and 30% reduction scenario
- Modelling future energy consumption, CO_2 emissions, and car fleet compilation, including new registrations
- Conducting economic consequence analysis of the two scenarios

Scenario parameters

The most important parameters for the scenarios were the composition of new registrations for vehicles, and the biofuel blends. The 30% scenario saw new registrations of passenger electric vehicles drive vehicles grow to 50% in 2030, with light commercial vehicles (LCV) (40%) and city buses (60%) also seeing a large growth.

% of 2030 new registrations	Cars		LCV		HDV		City busses		Coaches	
	BAU	30%	BAU	30%	BAU	30%	BAU	30%	BAU	30%
Pure electric	7.5	25	5	20			20	60		
Plugin Hybrid	7.5	25	5	20						
Gas (biogas)		2		5		6	5	5	0	6
Diesel	35	20	85	52	100	94	75	35	100	94
Petrol	50	28	5	3						

Table 2: New vehicle registrations in the 30% scenario and BAU scenario (% of new registrations)

The accelerated electrification of the transport sector in the 30% scenario entails an increased sale of electric vehicles. By 2030 new registrations would make up 9 million passenger cars with a total stock of 46 million including both battery electric vehicle and plug-in hybrids, thereby corresponding to 18% of the total passenger car fleet.

Electric passenger cars (1,000 cars)	2015	2020	2025	2030
New registrations	170	860	3,330	9,050
Stock of vehicles	360	3,350	14,650	46,570

Table 3: Number of electric passenger cars (EV + PHEV) in the 30% scenario

In the analysis, biomass blends should first and foremost comply with the proposed requirements under the EU Winter Package. In the 30% scenario, these requirements are considered insufficient in order to obtain the overall target of 30% CO_2 reduction by 2030, and consequently, the biofuel blends were increased. Methodologically speaking, all other measures, such as electrification, efficiency improvements of conventional vehicles, and conversion to gas (biogas), contribute with what was considered to be their maximum realistic share. Biofuels were then assumed to deliver the residual CO_2 reduction. However, there exist several restrictions on biofuel blends:

- 1.g biofuels cannot represent more than 3.8% of total energy consumption for road transport by 2030 due to EU requirements
- The amount of FAME is limited by a blend wall of 7% by volume, i.e. the diesel engine is not compatible with blends exceeding this amount.
- Not all petrol cars are compatible with high ethanol blends. For bio-ethanol, it is assumed that the dominant fuel standard is E10 from 2020, while all new vehicles are compatible with an E20 standard from 2020-2025 onwards. By 2030, all vehicles bought during 2020-2025 and thereafter, consume E20.

It is assumed that drop-in fuels for diesel can be mixed in unlimited shares without restricting the diesel engine. This implies that drop-in fuels are assumed to deliver the residual CO_2 reduction once the other biofuels have contributed with their maximum within the above-described limits.

The resulting biofuel blending percentages for the two scenarios are presented in the table below. In the 30% scenario, the total biofuel blend in diesel is 12.6% in 2030, comprised of 6.5% FAME/RME and 6.1% of 2.g diesel drop ins.

Biofuel blends in 2030	Food crops (1.g)		Advanced (2.g)		Total	
	BAU	30%	BAU	30%	BAU	30%
FAME/RME	6%	4.7%	0.5%	1.7%	**6.5%**	**6.5%**
Diesel drop-ins (HVO, F-T Syndiesel)				6.1%		**6.1%**
Bio-ethanol	5.9%	0.6%	0.5%	10.4%	**6.4%**	**11%**
Biogas			100%	100%	**100%**	**100%**

Table 4: Biofuel blends in 2030 in the BAU and 30% scenarios

Key References

- ”A harmonised Auto-Fuel biofuel roadmap for the EU to 2030”, E4TECH, 2013
- “Biogas og andre VE brændstoffer til tung transport” (Biogas and other renewable fuels for heavy transport), Ea Energy Analyses and the University of Southern Denmark, 2016
- “CO_2 reduction technologies for the European car and van fleet, a 2025-2030 assessment”, ICCT, 2016
- ”Electric Vehicles – Technology Brief”, IRENA, 2017
- ”Electrifying insights – How automakers can drive electrified vehicle sales and profitability”, McKinsey, 2017
- “European vehicle market statistics – Pocketbook 2015/2016”, ICCT, 2015.
- “European motor vehicle parc”, European Automobile Manufacturers’ Association (ACEA), 2014
- ”EU Energy Balance Sheets”, Eurostat, 1990-2014
- ”EU Transport in figures – Statistical pocketbook 2015”, European Commission, 2015
- ”EU Transport in figures – Statistical pocketbook 2014”, European Commission, 2014
- ”EU Transport in figures – Statistical pocketbook 2013”, European Commission, 2013
- ”EU Transport in figures – Statistical pocketbook 2012”, European Commission, 2012
- Eurostat (various databases)
- ”EU Reference Scenario 2016”, EU Commission, 2016
- “From Laboratory to Road – A 2016 update of official and real-world fuel consumption and CO_2 values for passenger cars in Europe”, ICCT, 2016
- “Global EV Outlook 2016”, IEA, 2016.
- Gov.uk (traffic statistics)
- ”Green Roadmap 2030”, Ea Energy Analyses, 2016
- “Monitoring CO_2 emissions from passenger cars and vans in 2015”, EEA, 2016
- "Monitoring of CO_2 emissions from passenger cars - Data 2015" EEA, 2016
- “Quantifying the impact of real-world driving on total CO_2 emissions from UK cars and vans”, Element Energy & ICCT, 2015
- ”Rammevilkår for gas til tung vejtransport” (Framework conditions for gas in heavy road transport), COWI, 2014
- “The potential for mass reduction of passenger cars and light commercial vehicles in relation to future CO_2 regulatory requirements”, Ricardo-AEA, TEPR, & TU GRAZ, 2015
- ”World Energy Outlook 2016”, IEA, 2016”